

## Two new freshwater gammarids (Crustacea: Amphipoda) from Lake Lugu, China

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**Two new freshwater gammarids (Crustacea: Amphipoda) from Lake Lugu, China.** - Two new species of the genus *Gammarus* (Amphipoda, Gammaridae) are described from Lake Lugu, Yunnan Province. Both *G. curvativus* sp. n. and *G. ninglangensis* sp. n. belong to the *G. pulex*-group.

**Key-words:** Amphipoda - *Gammarus* - new species - China.

### INTRODUCTION

Lake Lugu, with a total area of 52 square kilometers and at an elevation of 2,685 meters, is situated on the northwestern plateau of Yunnan in China. The beauty of the lake with its surrounding breath-taking scenery makes it an excellent tourist destination. At the same time, the ecological changes in the lake, probably caused by the misuse of alien fish species (Yang, 2001) also attract many biologists from all over the world. More than one decade ago, local people tried to establish grass carp in the lake, but by mistake they introduced *Pseudorasbora parva* Bleeker 1860, a species with little commercial value, which brought three species of native schizothoracine fish to near extinction (Xie & Chen, 1999). This obviously also affected the resident freshwater Amphipoda. During a recent expedition to the province of Yunnan, we were unable to collect any amphipod specimens in Lake Lugu. Therefore, the present study on the *Gammarus* amphipods of Lake Lugu is entirely based on museum specimens collected twenty years ago.

*Gammarus* is one of the largest genera of epigeal freshwater amphipods. 117 *Gammarus* species were described before 1983 (Barnard & Barnard, 1983). Later, Stock *et al.* (1998), Hou & Li (2002a, b, c, d), Hou, Li & Zheng (2002) and Hou, Li & Morino (2002) described additional species from Iran and China. According to the study by Karaman & Pinkster (1977a, b, 1987), these species can be subdivided into three artificial species groups: (1) the *G. pulex*-group (species without dorsal carina and with dense setation on pereopods 3 and 4 and uropod 3), (2) the *G. balcanicus*-group (species without dorsal carina and poorly setose pereopods 3, 4 and uropod 3), and (3) the *G. roeseli*-group (species with dorsal carina).

The species described in the present paper belong to the *G. pulex*-group. All holotypes, allotypes and part of paratypes examined in the present study are deposited at the Institute of Zoology, Chinese Academy of Sciences, Beijing (IZCAS). Part of paratypes are deposited in the Muséum d'histoire naturelle, Geneva (MHNG).

## DESCRIPTIONS

***Gammarus curvativus* sp. n.**

Figs 1-6

**Material:** Holotype male (IZCAS-I-A0032), Lake Lugu (27.7°N, 100.8°E), Yongning Town, Ninglang District, Yunnan Province; collected by Guoxiao Chen; August 12, 1981. Allotype female (IZCAS-I-A0033), same data as for the holotype. Paratypes: 30 males and 20 females (IZCAS), same data as for the holotype; 10 males and 10 females (MHNG), Zhongshi Village, Ninglang District, Yunnan Province, collected by Guoxiao Chen, August 10, 1981.

**Other material:** 3 males and 3 females (IZCAS), Lake Lugu, April 12, 1986; 20 males and 7 females (IZCAS), fish farm near Luoshui Village, Yongning Town, Ninglang District, Yunnan Province, collected by Guoxiao Chen; August 11, 1981.

**Etymology:** The Latin epithet “curvativus” refers to the long, curled setae of carpus and propodus of gnathopod 2.

**Diagnosis:** *Gammarus curvativus* sp. n. can be easily diagnosed by the following characters: (1) accessory flagellum of first antenna 2-articulate, (2) gnathopod 2 with long curled setae on dorsal margin of carpus and weakly curled setae on dorsal margin of propodus, (3) inner ramus of uropod 3 less than half as long as article 1 of outer ramus, both rami densely armed with long, simple setae.

**Description of male:** Body 10.05 mm in length. Lateral lobe of head truncate, inferior antennal sinus deep, eyes reniform (Fig. 1A). Antenna 1 (Fig. 1D): peduncular articles 1-3 with length ratios of 1.0 : 0.67 : 0.47, all with distal setae and several setae on posterior margins; flagellum with 19 articles, most of them bearing aesthetascs; accessory flagellum with 2 articles. Antenna 2 (Fig. 1E): peduncular article 4 a little shorter than article 5, article 4 with 2 groups of short setae along anterior and posterior margins and with 2 groups of setae on inner surface, article 5 bearing 3-4 groups of setae along anterior and posterior margins and 3 groups of setae on inner surface; flagellum with 11 articles, posterior 7 articles with calceoli.

Upper lip rounded (Fig. 2H). Left mandible (Figs 2A, B): incisor with 5 teeth; lacinia mobilis with 4 dentitions; spine row with 9 plumose setae; molar with 1 seta; article 2 of palp with 15 stiff setae, article 3 about 85% of article 2 in length, bearing 4 B-setae, two groups of A-setae, 4 E-setae and a row of D-setae (according to Cole, 1980). Right mandible (Figs 2C, D): incisor with 4 teeth; lacinia mobilis bifurcate; article 2 of palp with 5 stiff setae, article 3 about 83% of article 2 in length, with two groups of A-setae, two groups of B-setae, 5 E-setae and a row of D-setae. Lower lip (Fig. 2I): inner plates absent. Maxilla 1 (Figs 2E, G): inner plate with 13 plumose setae; outer plate with 11 serrated spines; article 2 of left palp with 8 pointed spines accompanied by 4 stiff setae; right palp with 6 blade-like spines accompanied by 1 seta. Maxilla 2 (Fig. 2F): inner plate with 13 plumose setae on inner surface; outer plate a little longer than inner plate, with long apical setae. Maxilliped (Fig. 2J), inner plate with 3 apical blunt spines and 1 subapical spine; outer plate broad, with 11 slender spines on inner margin and 3 pectinate setae apically; article 3 of palp with 3 groups of setae, article 4 unguiform.

Coxal plate 1 (Fig. 3A) weakly dilated distally; coxal plates 2 and 3 (Figs 3C, 4B) subrectangular, bearing 1 seta on anterior corner and 1 seta on posterior corner; coxal plate 4 (Fig. 4A) with posterior excavation, longer than wide, bearing 3 setae on posterior margin; coxal plates 5 and 6 (Figs 4C, D) with small anterior lobes, posterior corners with 1 seta; coxal plate 7 (Fig. 4E) with 4 setae on posterior margin.

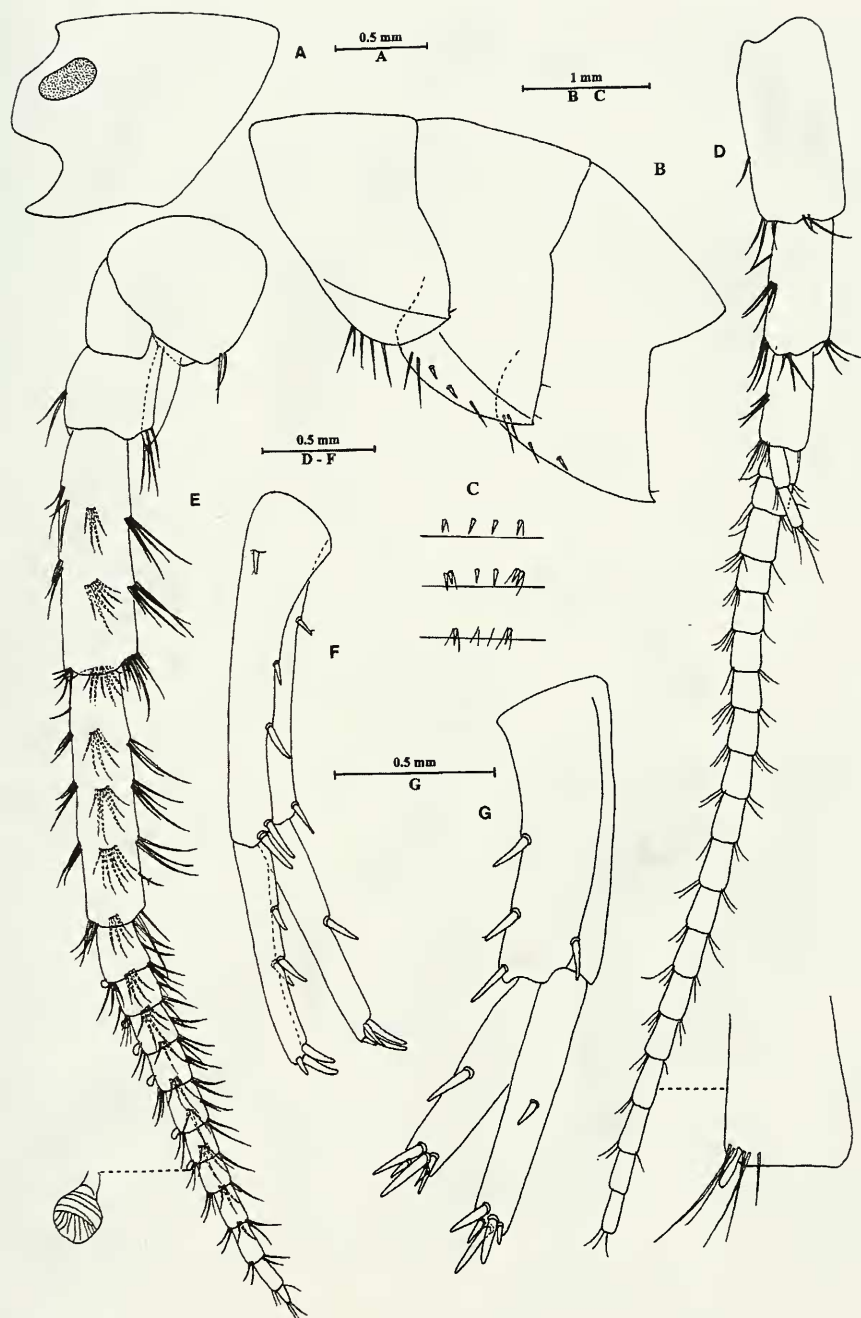


FIG. 1

*Gammarus curvativus* sp. n., holotype, male. A, head; B, epimeral plates; C, urosomites 1-3 (dorsal view); D, antenna 1; E, antenna 2; F, uropod 1; G, uropod 2.

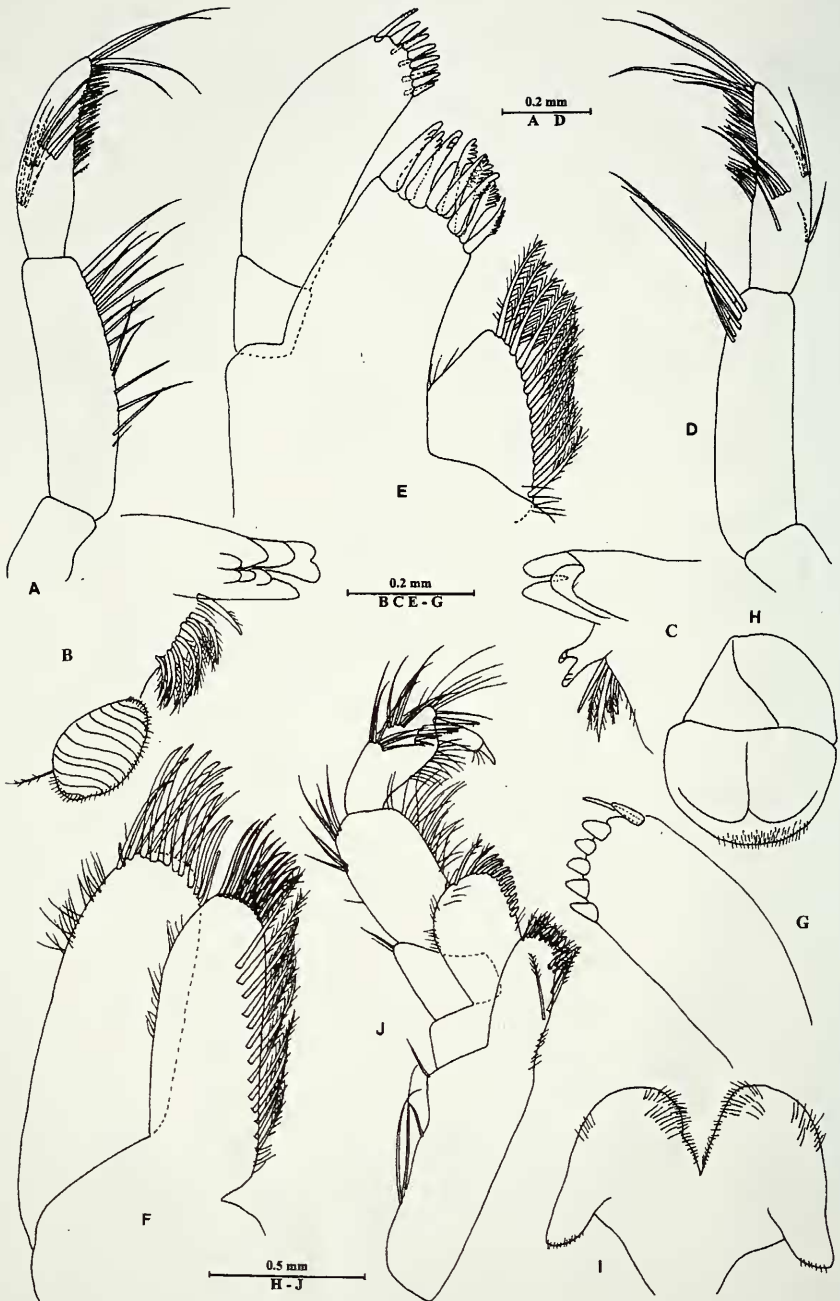


FIG. 2

*Gammarus curvativus* sp. n., holotype, male. A, palp of left mandible; B, incisor of left mandible; C, incisor of right mandible; D, palp of right mandible; E, left maxilla 1; F, maxilla 2; G, palp of right maxilla 1; H, upper lip; I, lower lip; J, maxilliped.



FIG. 3

*Gammarus curvativus* sp. n., holotype, male. A, gnathopod 1; B, propodus of gnathopod 1; C, gnathopod 2; D, propodus of gnathopod 2.



Gnathopod 1 (Figs 3A, B): basis with long setae on both sides, bearing 3 plumose setae distally; length ratio of carpus and propodus 1.0 : 1.1, carpus triangular, with 3 clusters of setae on dorsal anterior margin; palm of propodus oblique, bearing a single spine anteriorly, and 1-2-2-1-1 spines on posterior margin, and 1-1-2-3 spines on inner surface; dactylus about half as long as palm, bearing 1 seta on outer margin, nail short. Gnathopod 2 (Figs 3C, D): basis similar to that of gnathopod 1; length ratio of carpus and propodus 1.0 : 1.1, carpus parallel-sided, bearing 4 groups of long curled setae on dorsal margin; propodus with 4 groups of long and weakly curled setae on dorsal margin, palm transverse, with 1 blunt spine anteriorly, 3 single and 2 pairs of spines on outer and inner posterior corners, respectively; dactylus with 1 seta on outer margin and 1 seta at hinge of nail.

Pereopod 3 (Figs 4B, G): basis to carpus with long, straight setae on posterior margins, dactylus stout. Pereopod 4 (Figs 4A, F) similar to pereopod 3.

Pereopods 5-7 (Figs 4C-E, H-J): anterior margins of bases with several long setae and 5 short spines; posterior margin nearly straight in pereopod 5, slightly concave in pereopod 6, and expanded in pereopod 7, with about 10 short setae; inner surface of basis of pereopod 7 with 10 setae. Merus and carpus with 2 groups of 2-3 spines accompanied by short setae on anterior margin; propodus with 3 groups of 2-3 spines on anterior margin; dactylus slender, with 1 seta on outer margin and 1-2 setae at hinge of nail.

Coxal gills of pereopods 2-7 sac-like, coxal gill 7 smallest.

Epimeral plates 1-3 (Fig. 1B) with 1-2 short setae on posterior margins, epimeral plate 1 ventrally rounded, with 5 setae on anterior corner; epimeral plate 2 pointed, with 2 setae and 3 spines on ventral margin; epimeral plate 3 acute, with 2 setae and 2 spines on ventral margin. Pleopods 1-3 subequal (Figs 5C-E), peduncles with groups of long setae, bearing 2 retinaculae accompanied by 2-3 long setae; both rami about 18 articles, armed with plumose setae.

Urosomites 1-3 not humped (Fig. 1C), urosomite 1 with 1-1-1-1 spines on dorsal margin, urosomite 2 with 2-1-1-2 spines, urosomite 3 with 1-1 spines, each spine accompanied by 1-2 setae. Uropod 1 (Fig. 1F): peduncle longer than rami, with 1 basofacial spine, 1-1-2 and 1-1 spines on outer and inner margins, respectively; outer ramus with 2 spines and 1 spine on outer and inner margins, respectively; inner ramus with 1 spine. Uropod 2 (Fig. 1G): peduncle with 3 spines and 1 spine on outer and inner margins, respectively; both rami with 1 marginal spine. Uropod 3 (Fig. 5A): peduncle with 3 spines accompanied by some setae; inner ramus less than half as long as article 1 of outer ramus; article 1 of outer ramus with 2 spines on outer margin and 4 spines distally, article 2 longer than adjacent spines; both rami densely ornamented with long, simple setae.

Telson deeply cleft (Fig. 5B), as long as wide, each lobe with 2 distal spines accompanied by 4 setae, and 3-4 setae on dorsal surface.

*Description of female:* Length 8.3 mm. Gnathopod 1 (Figs 6A, B): basis with long setae along anterior and posterior margins, carpus shorter than propodus, palm of propodus not as oblique as that of male, with 6 spines on posterior corner. Gnathopod 2 (Figs 6C, D): carpus and propodus more densely setose than those of gnathopod 1, propodus subrectangular, palm with 4 spines on posterior corner.

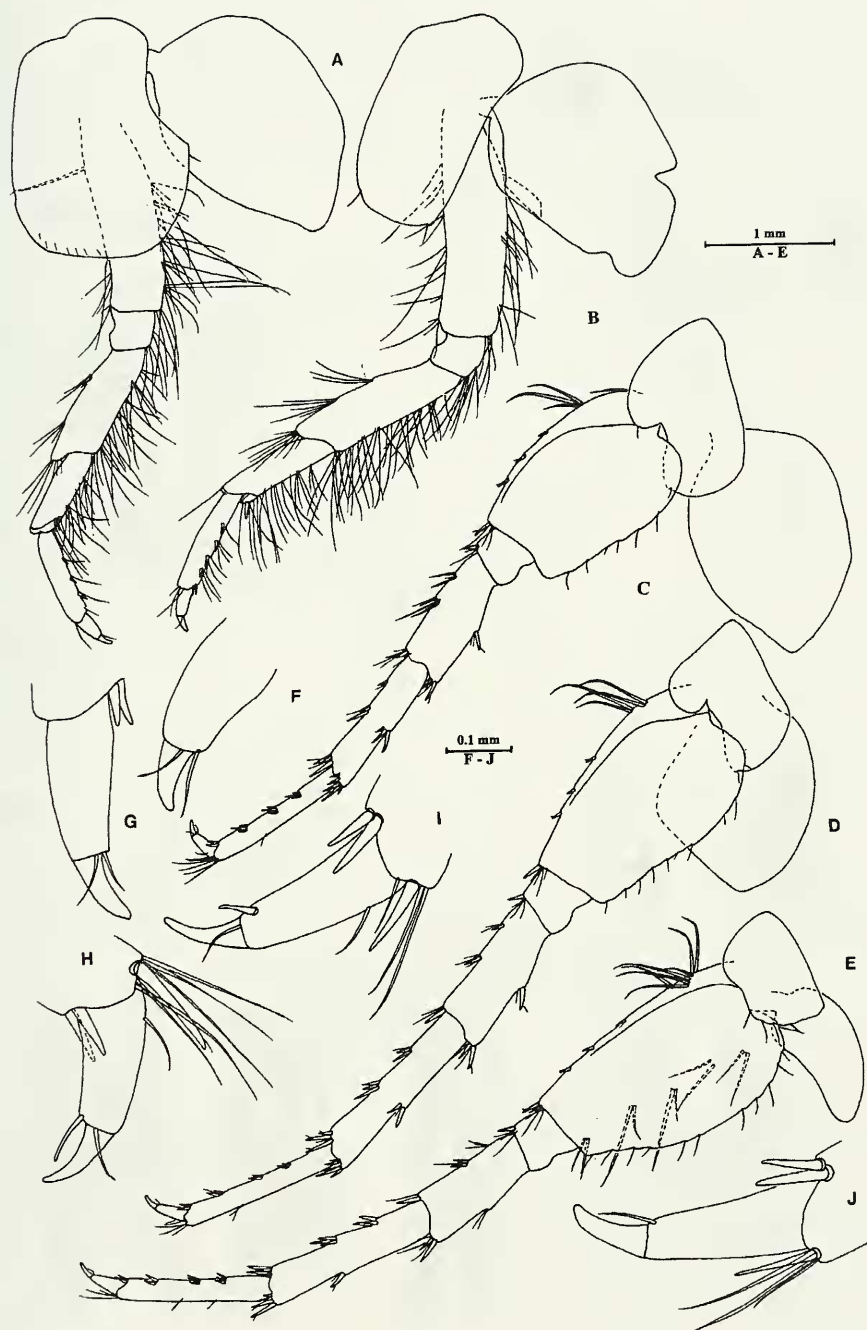


FIG. 4

*Gammarus curvativus* sp. n., holotype, male. A, pereopod 4; B, pereopod 3; C, pereopod 5; D, pereopod 6; E, pereopod 7; F, dactylus of pereopod 4; G, dactylus of pereopod 3; H, dactylus of pereopod 5; I, dactylus of pereopod 6; J, dactylus of pereopod 7.

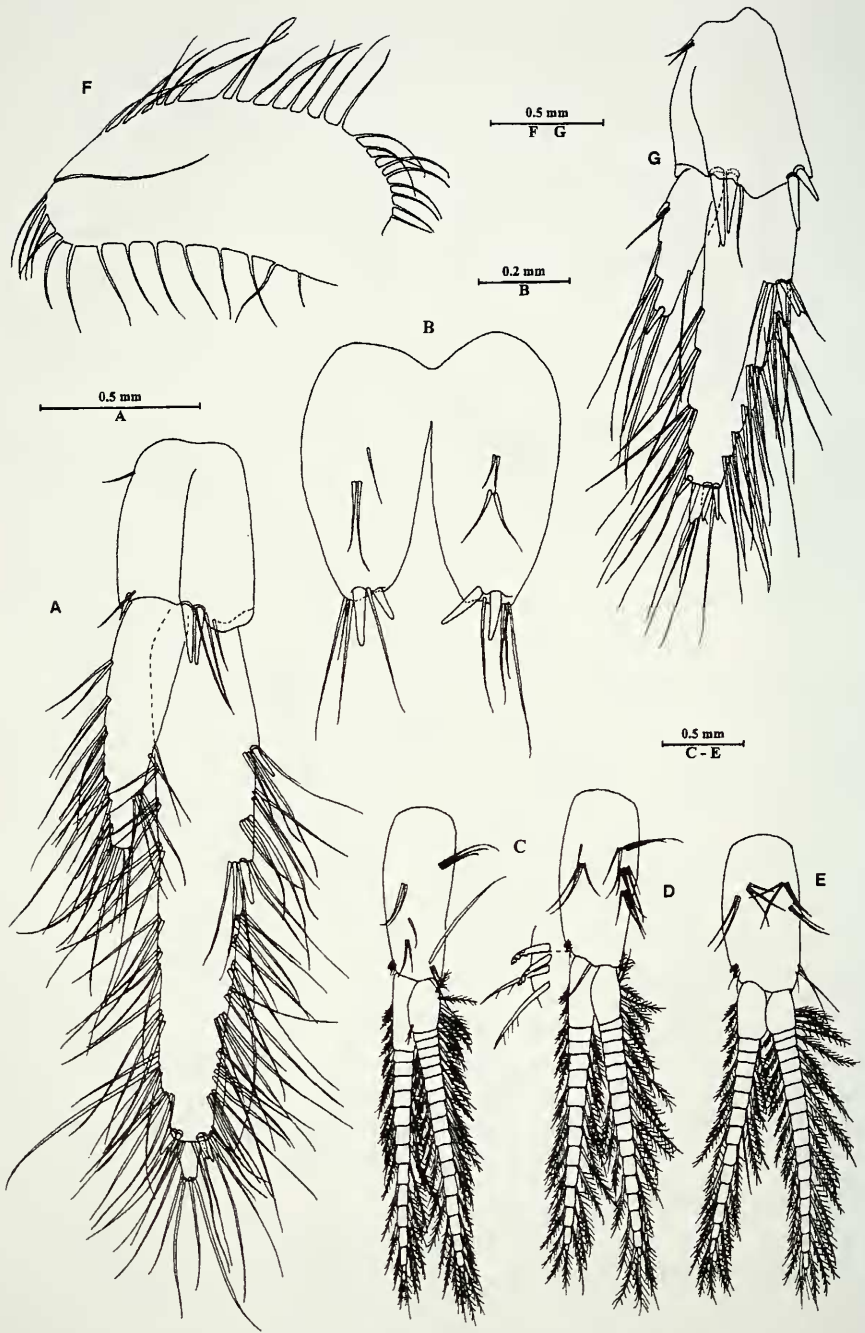


FIG. 5

*Gammarus curvativus* sp. n., male: A – E, female: F, G. A, uropod 3; B, telson; C, pleopod 1; D, pleopod 2; E, pleopod 3; F, oostegite of gnathopod 2; G, uropod 3.



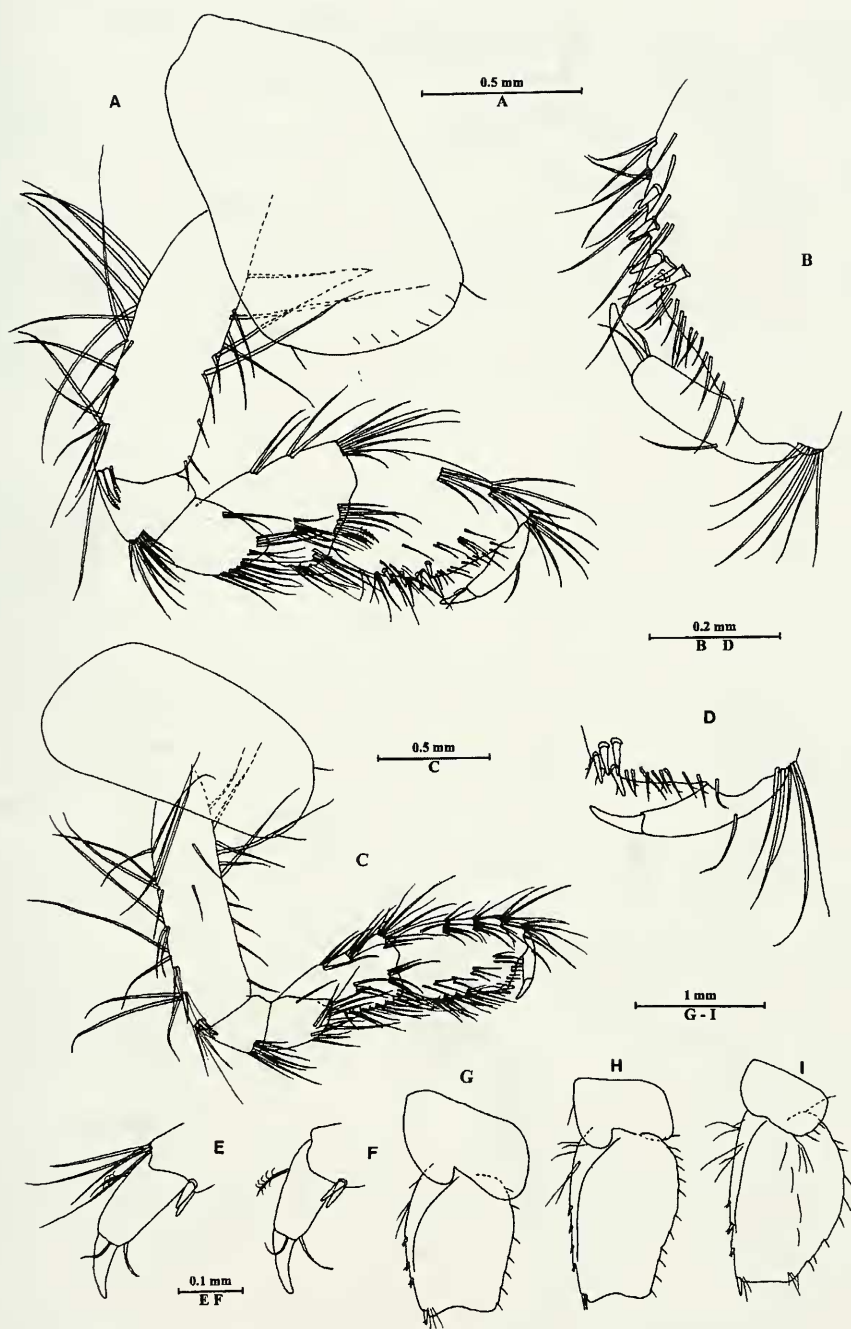


FIG. 6

*Gammarus curvativus* sp. n., allotype, female. A, gnathopod 1; B, propodus of gnathopod 1; C, gnathopod 2; D, propodus of gnathopod 2; E, dactylus of pereopod 3; F, dactylus of pereopod 4; G, basis of pereopod 5; H, basis of pereopod 6; I, basis of pereopod 7.

Pereopods 3 and 4 similar to those of male, dactyli curved (Figs 6E, F), bearing 1 seta on outer margins and 2 setae at hinges of nails, respectively.

Uropod 3 (Fig. 5G): inner ramus about half as long as article 1 of outer ramus, both rami with long simple setae.

Oostegites of pereopods 2-5 progressively smaller (Fig. 5A), ovoid, with long marginal setae.

*Remarks:* *Gammarus curvativus* sp. n. is morphologically similar to *G. gregoryi* Tattersall, 1924, in having an inner ramus of uropod 3 that is less than half as long as article 1 of the outer ramus while both rami are armed with long setae. The new species differs from the latter by the following characters: carpus and propodus of gnathopod 2 with long curled setae, inner surface of basis of pereopod 7 with setae, and urosomite 1 with 1-1-1-1 spines accompanied by setae on dorsal margin (*G. gregoryi* has no spines, but minute setae on the mid-dorsal margin of urosomite 1).

***Gammarus ninglangensis* sp. n.**

Figs 7-11

*Material:* Holotype male (IZCAS-I-A0034), fish farm near Luoshui Village, Yongning Town (27.7°N, 100.7°E), Ninglang District, Yunnan Province, collected by Guoxiao Chen, August 11, 1981. Allotype female (IZCAS-I-A0035); paratypes: 4 males (IZCAS), 4 males (MHNG), same data as for the holotype.

*Etymology:* The Latin epithet "ninglangensis" is derived from the district of origin of the new species.

*Diagnosis:* *Gammarus ninglangensis* sp. n. is characterized by the following characters: (1) gnathopod 2 with long straight setae on dorsal margins of carpus and propodus, (2) bases of pereopods 5-7 elongate relatively, bearing 3-4 short spines on anterior margins and a few short setae on posterior margins, (3) inner ramus of uropod 3 about 80% of outer ramus, outer ramus with 1 article, and both rami armed with long, plumose setae.

*Description of male:* Body length 11 mm. Lateral lobe of head oblique, inferior antennal sinus deep, eyes reniform, medium in size (Fig. 7B). Antenna 1 (Fig. 10A): peduncular articles 1-3 with length ratios of 1.0 : 0.72 : 0.5, each article with some marginal and distal setae; primary flagellum with 24 articles, most of them with aesthetascs; accessory flagellum with 4 articles. Antenna 2 (Fig. 10B): peduncular article 4 a little shorter than article 5, article 4 with 3 groups of setae on anterior and posterior margins, article 5 with 4 groups of setae on both margins; flagellum with 8 articles, posterior 6 articles with calceoli.

Upper lip rounded (Fig. 7L), with minute setae. Left mandible (Figs 7I, J): incisor with 5 teeth; lacinia mobilis with 4 weak dentitions; spine row with 8 plumose setae; molar triturative; article 2 of palp with 13 stiff setae, article 3 ca. 80% length of article 2, bearing 4 A-setae, three groups of B-setae, 20 D-setae and 5 E-setae. Right mandible (Fig. 7E): incisor with 4 teeth, lacinia mobilis bifurcate. Lower lip (Fig. 7K): inner plates absent. Maxilla 1 (Figs 7G, H): inner plate with 17 plumose setae; outer plate with 11 serrated spines; article 2 of left palp with 7 pointed spines accompanied by 3 stiff setae; article 2 of right palp with 6 blade-like spines accompanied by 1 plumose seta. Maxilla 2 (Fig. 7F): inner plate with oblique row of 25 plumose setae on inner face; outer plate with long apical setae. Maxilliped (Fig. 7M): inner plate with

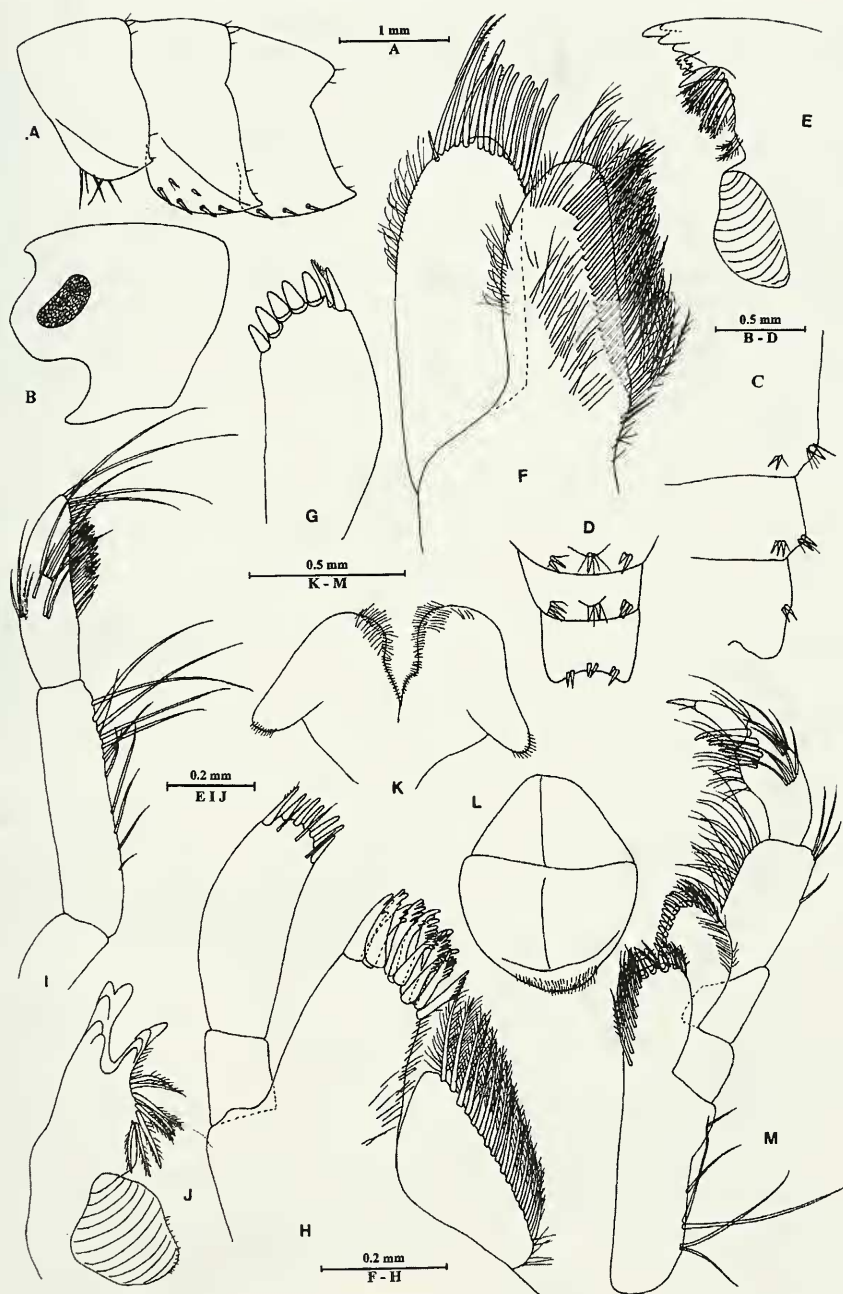


FIG. 7

*Gammarus ninglangensis* sp. n., holotype, male. A, epimeral plates; B, head; C, urosomites 1-3 (lateral view of dorsal part); D, urosomites 1-3 (dorsal view); E, incisor of right mandible; F, maxilla 2; G, palp of right maxilla 1; H, left maxilla 1; I, palp of left mandible; J, incisor of left mandible; K, lower lip; L, upper lip; M, maxilliped.

apical spines; outer plate expanded, with 10 slender spines on medial margin and 5 apical pectinate setae; article 3 of palp with numerous setae, article 4 cuspidate.

Coxal plates 1-3 subrectangular (Figs 8A, D, E), ventral margins with minute setae; coxal plate 4 with posterior excavation (Fig. 9A), longer than wide; coxal plates 5 and 6 (Figs 9B, C): anterior lobes small; coxal plate 7 (Fig. 9D) with 2 setae on anterior margin.

Gnathopod 1 (Figs 8A, B): basis with long setae along anterior and posterior margins, bearing 3 spinulate setae distally; carpus triangular, length about 73% that of propodus; propodus pyriform, palm oblique, bearing 1 medial spine anteriorly, and 12 spines on posterior margin and 4 spines on inner face; dactylus relatively short, with 1 seta on outer margin. Gnathopod 2 (Figs 8C, D), basis similar to that of gnathopod 1, length of carpus about 66% that of propodus; propodus subrectangular, palm truncate, bearing 1 spine anteriorly, and 7 spines on posterior corner; dactylus with 1 seta on outer margin, nail short.

Pereopod 3 (Figs 8E, F) a little longer than pereopod 4 (Figs 9A, E), both pereopods 3 and 4 with long straight setae on posterior margins accompanied by short spines; dactyli stout, bearing 1 seta on outer margins and 2 stiff setae at joints of nails, nails about 50% of corresponding dactyli length.

Pereopods 6 and 7 longer than pereopod 5 (Figs 9B-D, F-H). Bases of pereopods 5-7 relatively narrow and elongate, bearing 3-4 short spines and several long setae on anterior margins, posterior margins with a few short setae; merus and carpus with 2-3 groups of 2-3 spines along anterior and posterior margins; propodus with 4 groups of 3 spines on anterior margins; dactyli with 1 seta on outer margins and 2 spines at hinges of nails, nails short.

Coxal gills of pereopods 2-7 sac-like, coxal gill 7 smallest.

Epimeral plates 1-3 (Fig. 7A) posterior corners progressively acuminate, bearing 5-6 small setae on dorsal margins and 1-2 setae on posterior margins. Epimeral plate 1 with 5 long setae on anterior corner; plate 2 ventrally with 4 marginal spines and 2 submarginal spines; plate 3 with 3 spines on ventral margin. Pleopods 1-3 (Figs 10E-G): peduncles with some setae, and 2 retinaculae accompanied by 2 setae; both rami bearing 18 articles, fringed with plumose setae.

Urosomites 1-3 slightly humped (Figs 7C, D), bearing 3 clusters of spines dorsally. Uropod 1 (Fig. 10C): peduncle bearing 1 basofacial spine, with 1-1-1-2 spines on outer margin and 1 spine on medio-distal corner; outer ramus with 2 spines and 1 spine on outer and inner margins, respectively; inner ramus with 2 spines and 1 spine on outer and inner margins, respectively. Uropod 2 (Fig. 10D): peduncle with 3 spines and 1 spine on outer and inner margins, respectively; both rami with 1-2 marginal spines. Uropod 3 (Fig. 10H): peduncle with several dorsal setae and 5 distal spines; inner ramus about 81% length of outer ramus, with 2 spines on inner margin and 1 distal spine; outer ramus with 1 article, bearing 3 marginal and 4 distal spines; both rami densely armed with plumose setae.

Telson (Fig. 11A) longer than wide, deeply cleft, each lobe with 2 distal spines accompanied by several setae, and with 2 medial setae.

*Description of female:* Body length 7.5 mm. Antenna 1: peduncular articles 1-3 with length ratios of 1.0 : 0.61 : 0.41, flagellum with 18 articles, most of them with



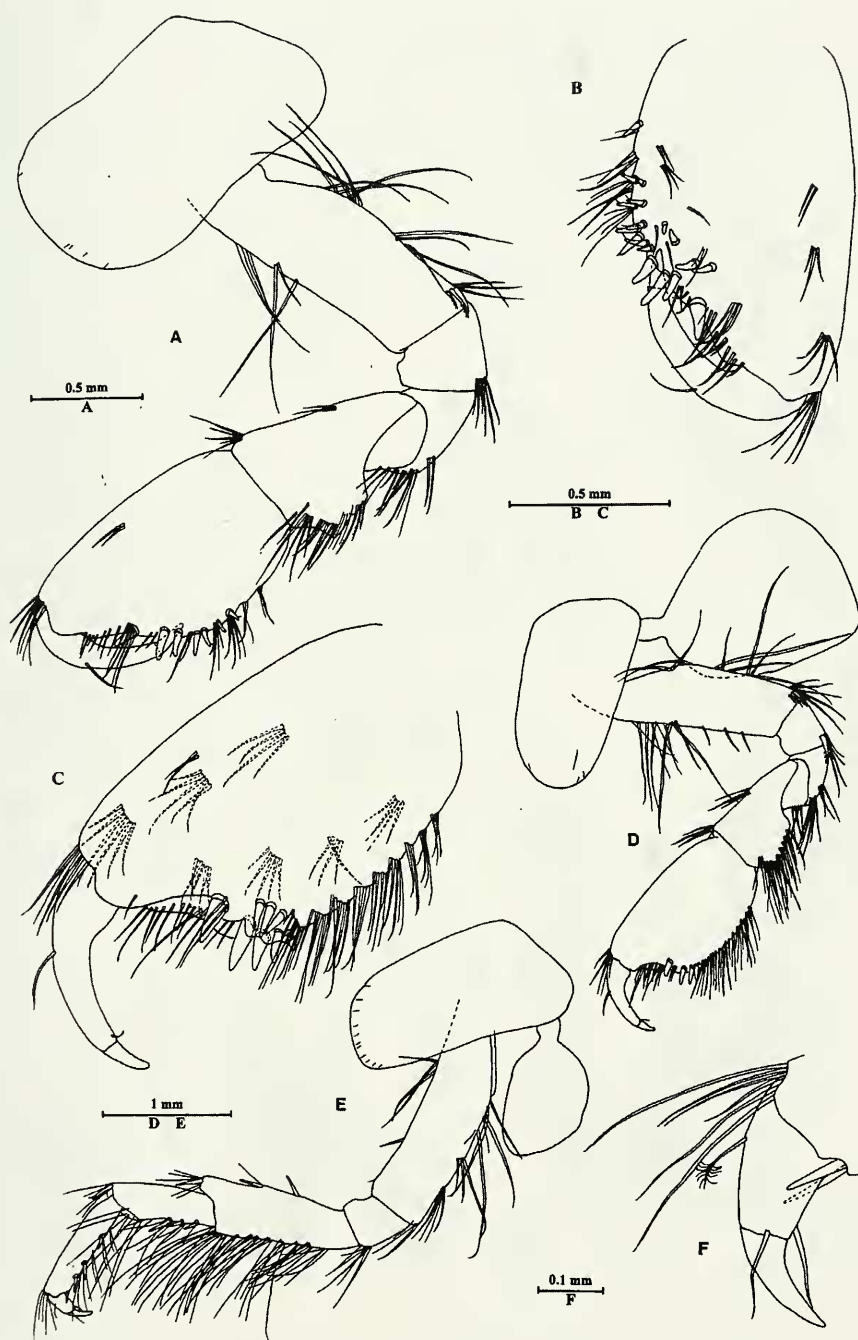


FIG. 8

*Gammarus ninglangensis* sp. n., holotype, male. A, gnathopod 1; B, propodus of gnathopod 1; C, propodus of gnathopod 2; D, gnathopod 2; E, pereopod 3; F, dactylus of pereopod 3.



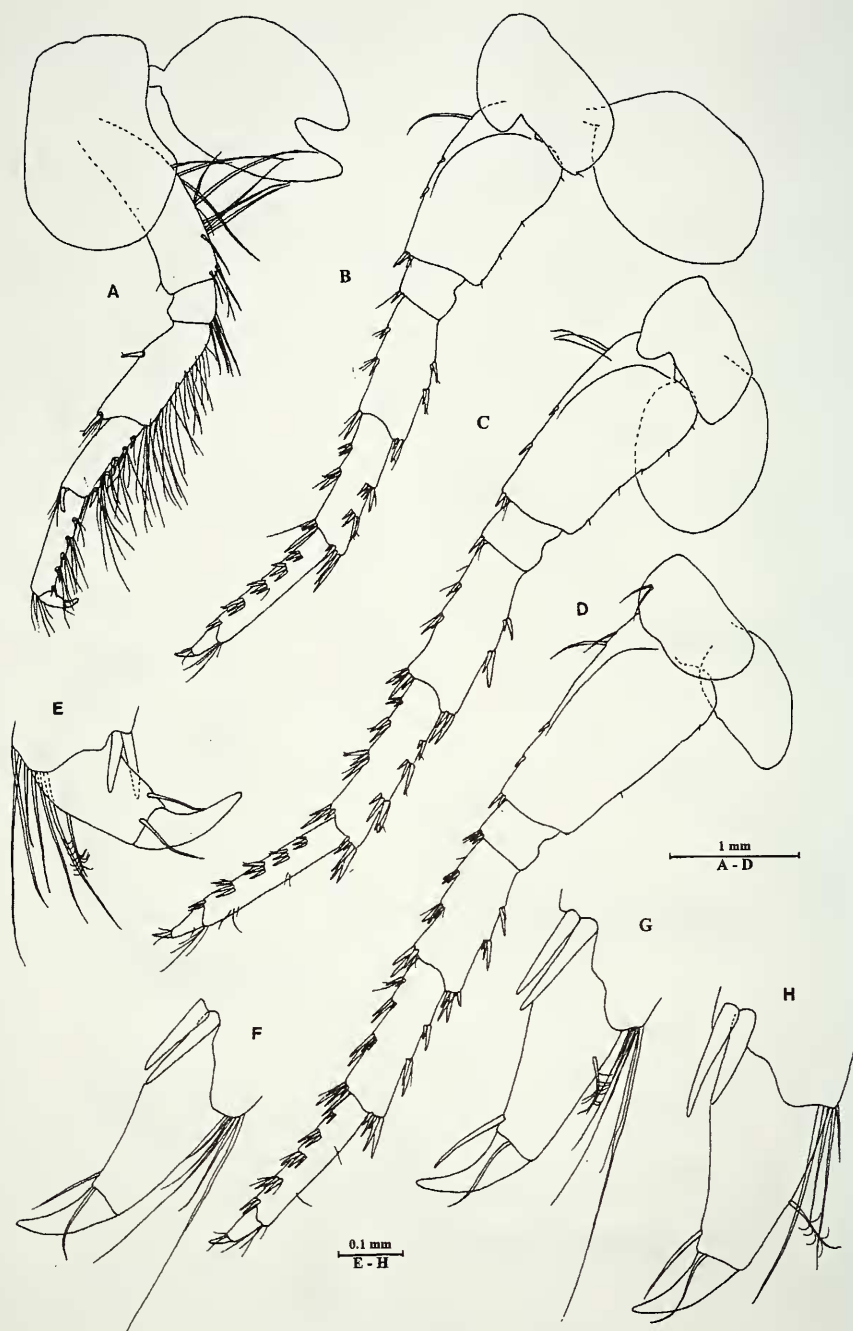


FIG. 9

*Gammarus ninglangensis* sp. n., holotype, male. A, pereopod 4; B, pereopod 5; C, pereopod 6; D, pereopod 7; E, dactylus of pereopod 4; F, dactylus of pereopod 5; G, dactylus of pereopod 6; H, dactylus of pereopod 7.

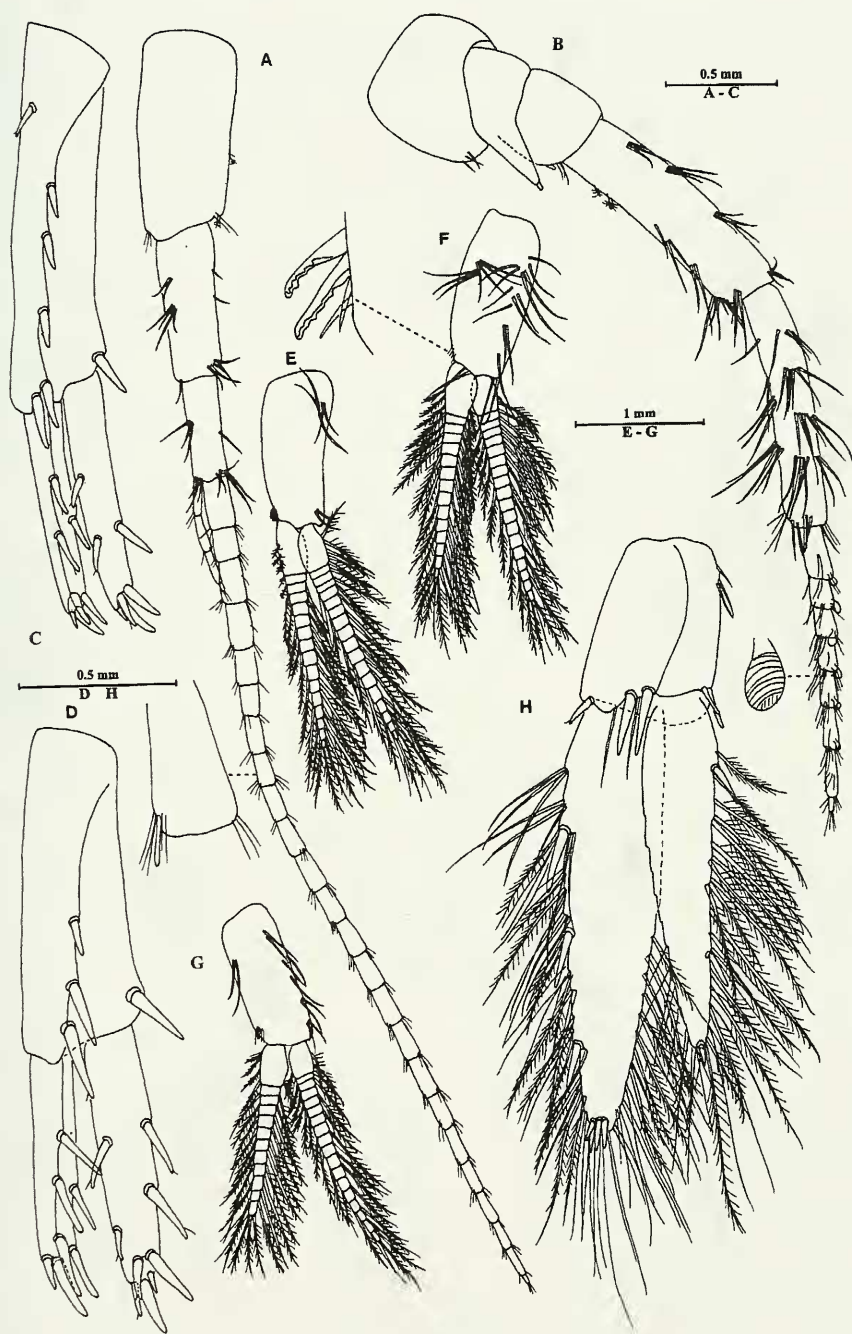


FIG. 10

*Gammarus ninglangensis* sp. n., holotype, male. A, antenna 1; B, antenna 2; C, uropod 1; D, uropod 2; E, pleopod 1; F, pleopod 2; G, pleopod 3; H, uropod 3.

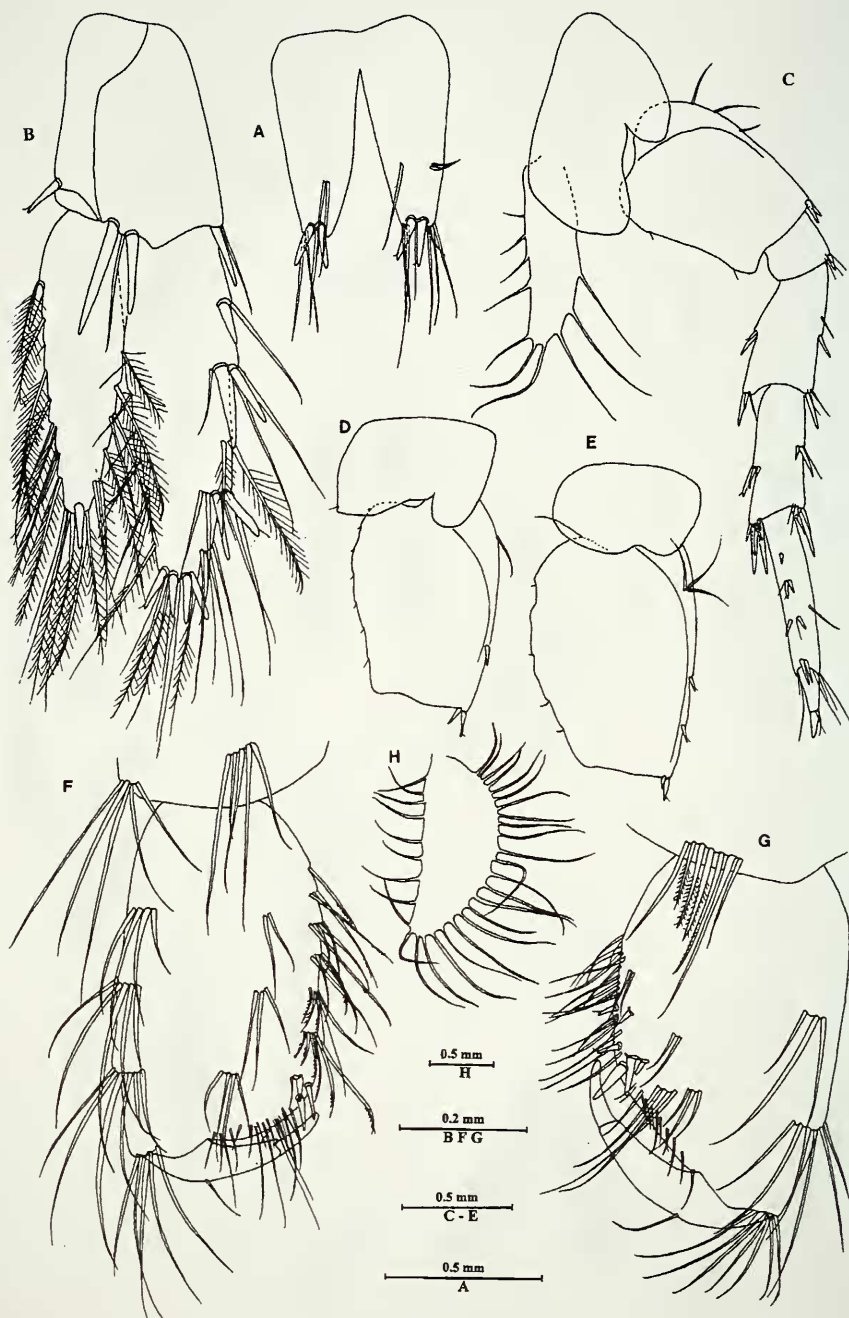


FIG. 11

*Gammarus ninglangensis* sp. n., male: A, female: B – H. A, telson; B, uropod 3; C, pereopod 5; D, basis of pereopod 6; E, basis of pereopod 7; F, propodus of gnathopod 2; G, propodus of gnathopod 1; H, oostegite of gnathopod 2.

aesthetascs; accessory flagellum with 3 articles, article 3 very short. Antenna 2: peduncular article 4 about as long as article 5, both with 2 groups of marginal setae; flagellum with 7 articles, calceoli absent.

Gnathopod 1 (Fig. 11G), carpus a little shorter than propodus; propodus not as oblique as that of male, with 6 spines on posterior corner; dactylus with 1 seta on outer margin. Gnathopod 2 (Fig. 11F), carpus parallel-sided; propodus subrectangular, with 3 groups of long setae on dorsal margin, palm transverse, with 3 spines on posterior corner.

Pereopods 3-4 similar to those of male.

Bases of pereopods 5-7 more expanded than in male (Figs 11C-E).

Oostegites of pereopod 2-5 elongated (Figs 11C, H), with numerous long marginal setae.

Uropod 3 stout (Fig. 11B): length of inner ramus about 88% of outer ramus, outer ramus with 1 article, bearing 1-2-2 marginal and 4 distal spines; both rami densely fringed with plumose setae.

Telson cleft, longer than wide, similar to that of male.

*Remarks:* *Gammarus ninglangensis* sp. n. is clearly distinguished from *G. curvativus* sp. n. by the following characters: gnathopods 1 and 2 only with straight setae, bases of pereopods 5-7 narrow and elongated, and inner ramus of uropod 3 reaching about 81% of outer ramus in length. Moreover, the outer ramus of uropod 3 possesses 1 article in *G. ninglangensis* sp. n., and both rami are densely armed with plumose setae.

*G. curvativus* sp. n. and *G. ninglangensis* sp. n. apparently are able to coexist in the same man-made environment, i.e. in fishponds.

Barnard and Dai (1988) redescribed *G. lacustris* Sars, 1863 based on material from Lijiang (26.8°N, 100.2°E), Yunnan Province, not far from the type locality of *G. ninglangensis* sp. n.. These two species are similar in the shape of gnathopods 1 and 2, the armature of pereopods 3-7, and the length ratio between inner ramus and article 1 of outer ramus. However, *G. lacustris* has acute posterodistal angles of epimeral plates 2 and 3 (slightly pointed in *G. ninglangensis*), and the distinct presence of a 2-articulated outer ramus of uropod 3.

## ACKNOWLEDGEMENTS

We are very grateful to Dr Peter Schwendinger (Muséum d'histoire naturelle, Geneva) and Dr Dirk Platvoet (University of Amsterdam, Amsterdam) for their continued support and encouragement throughout the present study. Thanks are also due to Mr Guoxiao Chen (IZCAS) for the donation of the material studied.

The present study was supported by the National Natural Sciences Foundation of China (NSFC-30270183, 39970102), National Science Fund for Fostering Talents in Basic Research (NSFC-J0030092), also partly supported by the project of Knowledge Innovation Program, Chinese Academy of Science (KSCX2-1-06A, KSCX3-IOZ-01) and the Life Science Special Fund of CAS supported by the Ministry of Finance (STZ-00-19).

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